Center Independent Research & Development: GSFC IRAD

3D Printing Complex Unitized Instrument Optical Benches and Metering Structures

Completed Technology Project (2013 - 2015)

Project Introduction

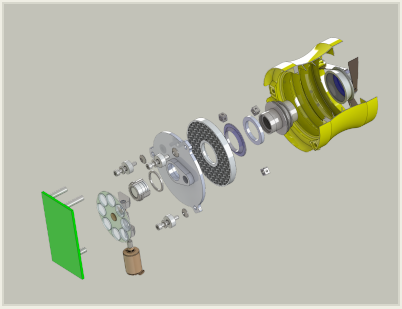
Additive machining technologies have advanced to a point where they can be utilized effectively for lowering mission costs. However, special design engineering approaches must be understood and demonstrated before additive machining can be used by flight project teams to reduce cost/risk at significant scales. We propose to manufacture an entire complex instrument structure, including optics, using additive machining to drastically reduce parts count and integration time, and demonstrate the non-standard design approaches required. The printed instrument will be subjected to environmental testing to qualify it for spaceflight, validating the manufacturing approach and reducing risk for future use of Direct Metal Laser Sintering (DMLS) components in flight programs.

This project will design and manufacture a small, cube-sat class imaging telescope using 3D printed components and traditional glass optics. The number of total parts will be reduced as 3D printing allows consolidation of traditionally separate components into complex unitary structures. 3D printed metal optics will also be manufactured to evaluate the stability and polishability of metal 3D printed mirrors. The resulting telescope will be subjected to environmental testing to increase the TRL of 3D printed metallic instrument components. The environmental testing will consist of subjecting the small telescope to vibration and thermal-vacuum to typical flight qualification levels to verify that the instrument will remain in focus. The flat mirrors are being printed out of aluminum and evaluated for single point diamond tool polishing, and will be subjected to thermal vacuum temperature cycling to evaluate figure stability.

The technique employed is a commercial additive manufacturing process called "Direct Metal Laser Sintering" (DMLS) that has potential applications to reduce costs for spaceflight instruments. It is a powder bed form additive machining that has been used extensively in the biomedical industry for inplants, and it has not yet been readily adopted by the aerospace industry. This research effort demonstrates how DMLS can be applied to imaging instruments to save time and cost through the reduction in parts count and improved part performance.

Anticipated Benefits

The benefits of this technology to funded missions are reduced costs due to faster manufacturing time, increased spaceflight component and assembly dimensional stability performance due to fewer interfaces, and lighter weight components due to the ability to optimize part geometry for stiffness in new ways.



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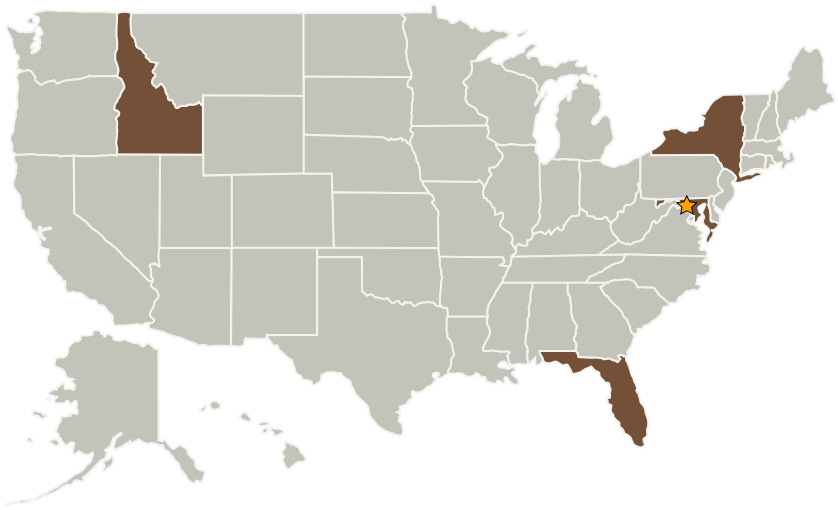
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Florida	Idaho
Maryland	New York

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

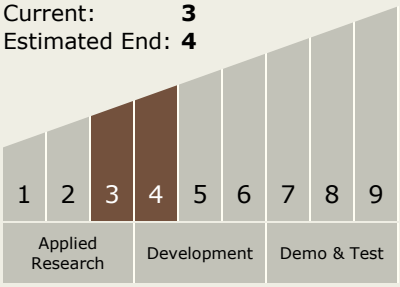
Theodore D Swanson

Principal Investigator:

Jason G Budinoff

Technology Maturity (TRL)

Start: **3**
Current: **3**
Estimated End: **4**



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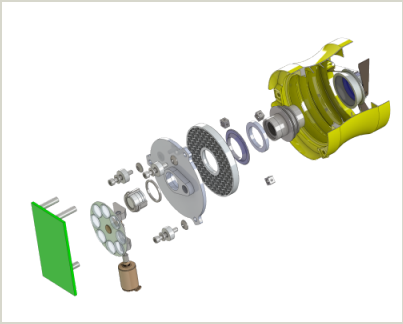
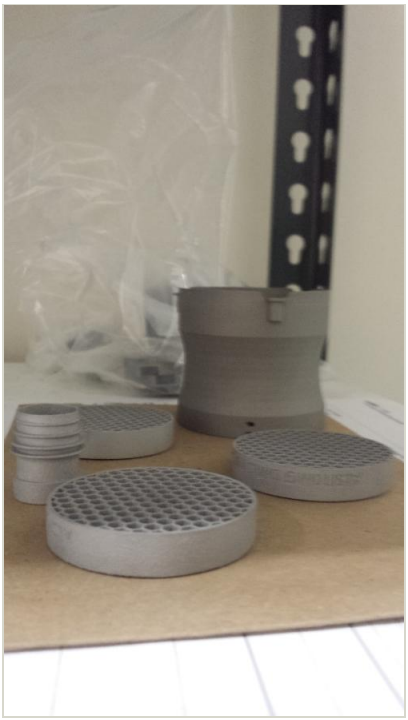
Images



3D Printing Complex Unitized Instrument Optical Benches and Metering Structures Project
3D Printing Complex Unitized Instrument Optical Benches and Metering Structures Project
(https://techport.nasa.gov/image/4026)



The first batch of 3D-printed components awaits inspection!
The aluminum mirror substrates in the foreground, and the titanium telescope tube is in the background.
(https://techport.nasa.gov/image/4223)

Stories

NASA engineer set to complete first 3-D-printed space cameras *(https://techport.nasa.gov/file/3208)*

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.4 Manufacturing
    - TX12.4.2 Intelligent Integrated Manufacturing